COHERENT PROPAGATION RESEARCH

Theodore G Birdsall
UMich group, Communications & Signal Processing Lab
Electrical Engineering and Computer Sciences Dept
University of Michigan
Ann Arbor MI 48109-2122
phone:(313) 764-5216, fax:(313) 763-8041, email: birdsall@umich.edu
Award #: N000149610791
Long-Range Propagation

LONG TERM GOAL

Enable improved ocean acoustic experimental research.

TECHNOLOGICAL OBJECTIVE

Facilitate the use of long range underwater acoustics through the use of energy gain signals and concept integrated signal processing.

APPROACH

I use a two pronged approach to facilitating long range propagation. I work with users or experimenters to integrate the use of energy-gain signals and custom designed processing to enable them to make better measurements (for 15 to 25 dB gain). And I develop the work of a graduate student into new areas of understanding of propagation modeling or into new arenas in signal processing.

During the past 20 years I have worked with oceanographers at Scripps Institute of Oceanography (Munk, Worcester, Dzieciuch) and at APL of the University of Washington (Spindel, Howe) on tomography and ATOC. I continue to learn needs and areas of difficulty from them.

WORK COMPLETED

The analysis of the Alternate Source Test measurements of July 1996 at 3 and 5 Mm were reported at the ONR OA Long Range Propagation workshop in March 1997. AST used simultaneous transmissions at two bands 1.6 octaves apart made possible by our unique drive signal. The low band was below the nominal source cutoff frequency.

The dissertation investigation into multimode dispersion correction for single phone, horizontal and vertical line arrays will be completed this year. This work was begun under ATOC (Acoustic Thermometry of Ocean Climate) and completed under ONR OA support.

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RESULTS

The multimodal dispersion correction processing goal was to provide the techniques necessary to time-compress and isolate individual modal arrivals in the presence of tens of modes. These were developed for propagation where modes naturally overlap in time, but most would not overlap if there were no dispersive time-spreading on each mode.

The development work used simulations of Megameter propagation on the 60-90 Hertz band, with subsequent application to the 20-90 Hz AST band. The study developed computer presentations for an operator, who then guided the computer in selecting related peaks using an HCC0 extractor.

The final development concentrated on the crescendo of a long range arrival, the muddled high-energy between the clearly defined and beamformable ray arrivals, and the terminal modes 2 and 1 which are relatively undispersed. The analysis of 3 and 5 Mm AST data required separation by the joint action of local pseudoinverse processing of the vertical line array data, followed by the dispersion correction on each pseudoinverse. The results agree with the ATOC investigators'conclusions that the propagation is by coupled modes, and the internal wave damage is evident at 5 Mm.

IMPACT/APPLICATIONS

The previous work on deterministic internal wave effects in three dimensions [Ref 1] has contributed to the communities'current interest in 3-D computations when oceanographic forces may divert propagation from the vertical plane between source and receiver.

The AST type of propagation measurement system will have an impact if research on frequency-dependent phenomena needs simultaneity in space and time, as compared to longer tests and statistical comparisons.

The processing for time-compression of modal dispersion needs further work in practical situations not dominated by mode-coupling. This would force direct effort onto refining a few features needed for success in each situation, thus building up a body of techniques and experience.

RELATED PROJECTS

I am working on the prescription fm signal design and receiver signal processing for a University of Hawaii mapping system. Such signals are custom designs, taking into account the electro-mechanical characteristics of the source, and designed to a prescribed energy density spectrum. The technique is intimately coupled to FIMF [Ref 2] receiver processing.

REFERENCES

[1] Deterministic three-dimensional analysis of long-range sound propagation through internal wave fields, M.L.Grabb, S.Wang, T.G. Birdsall, J.O.E., 21(3), pg 260-272 July 1996

[2] Factor inverse matched filtering, T.G.Birdsall and Kurt Metzger, jr, Jour.Acous.Soc.Am. 79(1) pg91-99 Jan 1986